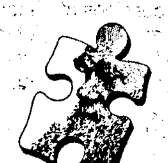
The lords of many domains

The circuits involved in reasoning work differently from "older" parts of the brain associated with survival, argue Leda Cosmides and John Tooby



Children learn to read using a different part of the brain than that
The evolved architecture of the human mind includes a number of

Both before and after Darwin, a common view among philosophers and scientists has been that the human mind resembles a blank slate, virtually free of content until written on by the hand of experience. According to Aquinas, there is "nothing in the intellect which was not previously in the senses." Working within this framework, the British Empiricists and their successors produced elaborate theories about how experience, refracted through a handful of innate mental procedures, inscribes content on to the mental slate. David Hume's view of these procedures was typical, and set the pattern for many later theories in psychology and the social sciences: "...there appear to be only three principles of connexion among ideas, namely Resemblance, Contiguity in time or place, and Cause or Effect."

Over the years, the technological metaphor used to describe the structure of the human mind has been updated, from blank slate to switchboard to general purpose computer, but the central tenets of empiricism have remained. Indeed, they have become the reigning orthodoxy in mainstream anthropology, sociology, and most areas of psychology. According to this orthodoxy, all of the specific content of the human mind originally derives from the "outside" — from the environment and the social world. This is because the evolved architecture of the human mind is thought to consist of reasoning circuits that are content-free, few in number and general-purpose. These general-purpose mechanisms sail under names such as "learning", "induction", "intelligence", "imitation", "rationality", "the capacity for culture", or simply "culture". By hallowed custom, their structure is typically specified by no more than a wave of the hand.

In this view, the same mechanisms are thought to govern how one acquires a language and a gender identity, an aversion to incest and an appreciation for beauty, a desire for friends and a fear of spiders indeed, every thought and feeling of which humans are capable. In other words, our innate mental procedures are assumed to operate uniformly, no matter what content, subject matter, or domain of life experience they are operating on. (For this reason, such procedures are described as content-independent or domain-general).

By definition, these empiricist mechanisms have no inherent content built in to their procedures, they are not designed to construct certain mental contents more readily than others, and they have no features specialised for processing particular kinds of content. The premise that these mechanisms have no content to impart is what leads to the conclusion that all the particulars of what we think and feel originate in the physical and social world.

Most theorists hold that the social world organises and injects meaning into individual minds. However, they reject the claim that the universal architecture of the human mind contributes to the organisation of the social world as well, imbuing it with characteristic meanings. According to this familiar view — what we have elsewhere called the Standard Social Science Model — the contents of human minds are free social constructions, and therefore the social sciences are autonomous and disconnected from any evolutionary or psychological foundation.

Three decades of research in cognitive psychology, evolutionary biology, and neuroscience have shown that this view of the human mind is radically defective. An alternative framework — sometimes called evolutionary psychology — is beginning to replace it. According to this view, the evolved architecture of the human mind is full of specialised reasoning circuits and regulatory mechanisms that organise the way we interpret and respond to our life experiences. These circuits inject certain recurrent concepts and motivations into our mental life, and they provide universal frames of meaning that allow us to understand the actions and intentions of others. Beneath the level of surface variability all humans share certain views and assumptions about the nature of the world and human action by virtue of these universal reasoning circuits.

Indeed, as Chomsky argued in the case of language, inherent mental content is what makes acquiring culture possible. Children enter the world completely ignorant of their local culture; therefore, they must deduce the meanings of words and acts on the basis of their observations. The task of learning the local culture is an impossible one for a blank slate, because if human life were not structured by these psychological universals, every unknown word or action by another could potentially mean any of an infinite number of things, and no hypothesis would be ruled out by any observation.

Our pan-human reasoning circuits narrow down the range of possible meanings to those consistent with universal assumptions about what human life is like. Moreover, they suggest likely interpretations of utterances and actions. Because of this set of reasoning circuits, children can succeed at the otherwise hopeless task of decoding and hence acquiring the cultures they are born into.

Where did these reasoning circuits come from? Darwin's gift to those who wish to understand the human mind was his discovery of the process that constructed it: evolution. Darwin wanted to explain how functional designs that are impressively well-engineered could emerge in a species spontaneously, without the intervention of a Divine Creator. His explanation, natural selection, provides an elegant causal account of the relationship between adaptive problems and the functional design features of organisms — the design features of our minds and those of other animals included. An adaptive problem is a problem whose solution tends to promote reproduction and that reappears across many generations.

Avoiding predators, locating food, reading emotional expressions, and communicating with others are examples of adaptive problems. New design features — such as a more sensitive retina, a new digestive enzyme, or a neural circuit that embodies a new rule of inference — are continually arising in populations by chance mutation. If a new design feature solves an adaptive problem better than existing alternatives, then it will cause its own spread. Over time, this causal feedback process tends to engineer designs that solve adaptive problems well.

The function of the brain — the reason why it appeared and became elaborated over evolutionary time — is adaptively to regulate behaviour and physiology in response to information derived from the body and the world. It is a naturally constructed computational system. Over evolutionary time, its circuits were cumulatively added because they "reasoned" or "processed information" in a way that enhanced the adaptive regulation of behaviour. Recognising that the brain's function is to process information allows cognitive scientists to resolve one of the mind/body problems. For cognitive scientists, brain and mind are terms that refer to the same system, but a system described in two complementary ways — either in terms of its physical properties (the brain), or in terms of its information-processing operation (the mind). The physical organisation of the brain evolved because it brought about certain information-processing relationships (ie, because it brought about an adaptive mental organisation).

Knowing that the circuitry of the human mind was designed by the evolutionary process tells us something centrally illuminating: that, aside from those properties acquired by chance or imposed by engineering constraint, the mind consists of a set of information-processing adaptations, designed to solve those adaptive problems that our hunter-gatherer ancestors faced generation after generation. The better we understand the evolutionary process, adaptive problems, and ancestral life, the more intelligently we can explore and map the intricacies of the human mind.

So how does the fact that the mind evolved speak to the debate about its structure? It is difficult to reconcile our knowledge of the evolutionary process with the empiricist claim that the mind consists of a small number of general purpose circuits that calculate Humean or logical relations. Natural selection should have built a mind full of specialised circuits instead. It is easy to understand the reason why.

A basic engineering principle is that the same device is rarely capable of solving two different problems equally well. We have both cups and cork screws because each solves a different recurring problem better than the other. It would be extremely difficult to drink from a corkscrew or open a wine bottle with a cup.

This same principle applies to the design of the human body. The heart is elegantly designed for pumping blood, but it is not good at detoxifying poisons; the liver is specialised for detoxifying poisons, but it cannot function as a pump. Pumping blood throughout the body and detoxifying poisons are two very different problems; consequently, the human body has a different machine for solving each of them. In biology, machines like these — ones that are specialised and functionally distinct — are called adaptive specialisations. Specialisation of design is natural selection's signature and its most common result. In fact, the more important the adaptive problem, the more intensely natural selection tends to specialise and improve the performance of the mechanism for solving it.

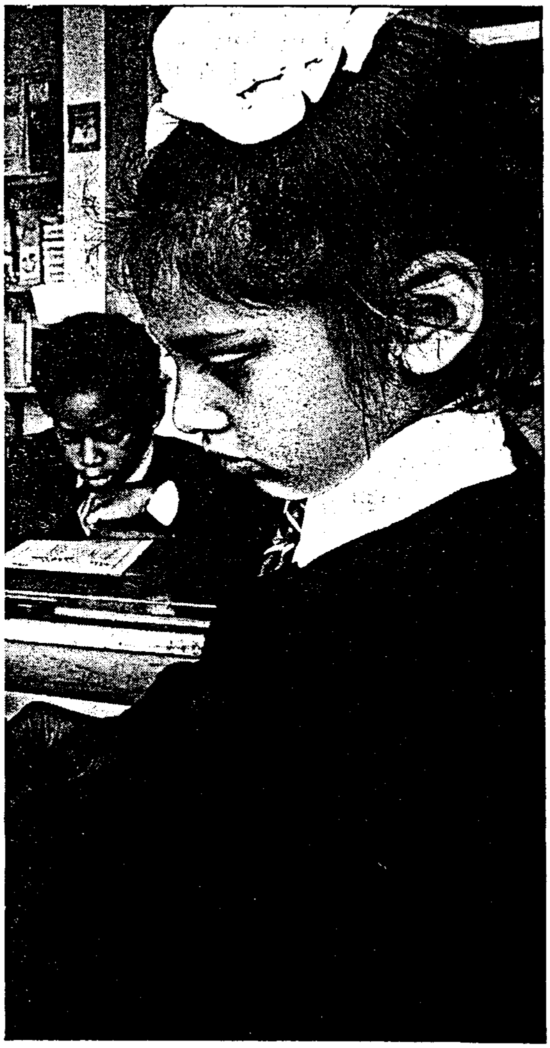
No less should be true of the brain and mind. The cognitive programmes that govern how you choose a mate should be different from the cognitive programmes that govern how you choose your dinner. When different information-processing problems have different engineering solutions, implementing these solutions often requires different, functionally distinct mechanisms. Speed, reliability and efficiency can be engineered into specialised mechanisms because they do not need to compromise between mutually incompatible task demands: a jack of all trades — assuming one is possible at all — is necessarily a master of none. For this reason, we should expect the evolved architecture of the human mind to include a number of functionally distinct cognitive adaptive specialisations.

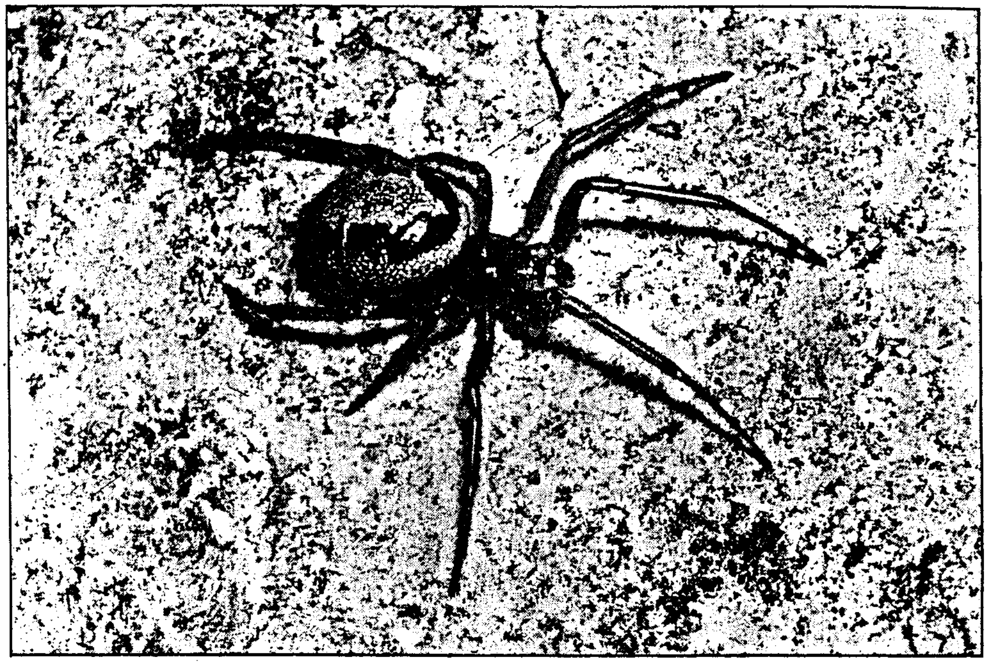
And it does. For example, the learning mechanisms that govern language acquisition are different from those that govern the acquisition of food aversions, and both of these are different from the learning mechanisms that govern the acquisition of snake phobias. These adaptive specialisations are domain-specific: the specialised design features that make them good at solving the problems that arise in one domain (avoiding venomous snakes) make them bad at solving the problems that arise in another (inducing a grammar).

They are also content-dependent: they are activated by different kinds of content (speech versus screams), and their procedures are designed to accept different kinds of content as input (sentences versus snakes). A mind that applied general purpose reasoning circuits to all these problems, regardless of their content, would be a clumsy problem-solver indeed; but flexibility and efficiency of thought and action can be achieved by a mind that contains a battery of special purpose circuits.

Circuits designed to work effectively in one environment may not mesh well with another. Our ancestors hunted and gathered for hundreds of thousands of years. Although their way of life has largely vanished, their reasoning circuits have not. They have been passed down to all of us, and are enduring components of our cognitive architecture. Appropriate or not, they structure the content of our modern minds, leaving their imprint on our cultural beliefs and institutions.

If such a view has any merit, it





needed to recognise the danger from spiders.
functionally distinct adaptive specialisations

must not only be argued for on theoretical grounds — however compelling — but must be substantiated by empirical evidence. The eventual goal is to recover out of carefully designed experimental studies "high resolution" maps of the intricate mechanisms that collectively constitute the mind. Toward this end, we have conducted an experimental research programme over the past ten years, exploring the hypothesis that the human mind contains specialised circuits designed for reasoning about adaptive problems posed by the social world of our ancestors. We initially focused on social exchange — co-operation for mutual benefit.

We select this topic for several reasons. First, the evolutionary theory of social exchange (also called co-operation, reciprocal altruism, or reciprocation) is relatively well-developed and unambiguous. Consequently, certain features of the functional logic of social exchange can be confidently relied on in constructing hypotheses about the structure of the information-processing procedures that this activity requires. Second, complex adaptations are constructed in response to evolutionarily long-enduring problems, and evidence from primatology and paleoanthropology support the view that our ancestors have engaged in social exchange for at least several million years.

Third, theories about reasoning and rationality have played a central role in both psychology and the social sciences. As a result, research about reasoning on social exchange can function as a powerful test of the traditional social science postulate that the evolved architecture of the mind consists solely or predominantly of a small number of content-independent, general-purpose mechanisms.

Traditionally, hypotheses that are inconsistent with this content-free view of the mind are, a priori, not considered credible, and the data that supports them are usually explained away by invoking as alternatives the operation of general purpose processes of an unspecified nature. Strong results indicating the involvement of domain-specific adaptations in areas such as perception, language, and emotion, have sometimes — though grudgingly — been accepted as genuine, but have been ghettoised as exceptional cases, not characteristic of the great majority of mental processes. In this dialogue, reasoning has served as the paradigm case of the "general purpose" psychological process: it has been viewed as pre-eminently characteristic of those processes that are purportedly the central engine of the human mind. Even vigorous advocates of the existence of content-dependent processes, such as the philosopher Jerry Fodor, have held "central" processes, such as reasoning, to be general purpose and content-independent.

Consequently, we felt that investigating reasoning about social exchange offered an excellent opportunity to cut to the quick of the controversy. If even human reasoning, the doctrinal "citadel" of the advocates of content-free, general purpose processes, turns out to include a large number of content-dependent cognitive adaptations, then the presumption that psychological mechanisms are characteristically domain-general and originally content-free can no longer be accorded privileged status. Such results would jeopardise the assumption that whenever content-dependent psychological phenomena are found, they necessarily imply the prior action of cultural or environmental shaping. Instead, it would add credibility to the contrary view that the mind is richly textured with content-specialised psychological adaptations.

Social exchange behaviour is both universal and highly elaborated across cultures, presenting itself in many forms: reciprocal gift-giving, food sharing, trade, and so on. It appears to be an ancient, pervasive and central part of human social life, that has constituted a long-enduring selection pressure on the hominid line. The evolutionary analysis of social exchange parallels the economist's concept of trade. Sometimes known as "reciprocal altruism", social exchange is an "I'll scratch your back if you scratch mine" principle. In evolutionary biology, researchers such as George Williams, Robert Trivers, W. D. Hamilton, and Robert Axelrod have analysed constraints on the evolution of social exchange, more recently applying game theory and modelling it as a repeated Prisoner's Dilemma. For the purposes of our research, the most important constraint is that social exchange ordinarily cannot evolve in a species unless individuals have some means of detecting those who fail to reciprocate favors — cheaters — and of excluding them from future interactions.

This led us directly to the hypothesis that humans might have evolved inference procedures that are specialised for detecting cheaters. A large literature already existed showing that people are not very good at detecting logical violations of "if-then" rules, even when these rules deal with familiar content drawn from everyday life. For example, suppose you are sceptical when an astrologer tells you, "If a person is a Leo, then that person is brave," and you want to prove him wrong. In looking for exceptions to this rule, you will probably investigate people who you know are Leos, to see whether they are brave. Many people also have the impulse to investigate people who are brave.

Yet investigating brave people would be a waste of time; the astrologer said that all Leos are brave — not that all brave people are Leos — so finding a brave Virgo would prove nothing. And if you are like most people, you probably won't realise that you need to investigate cowards. Yet a coward who turns out to be a Leo would represent a violation of the rule. If your mind had reasoning circuits specialised for detecting logical violations of rules, it would be immediately obvious to you that you should investigate Leos and cowards. But it is not intuitively obvious to most subjects. In general, fewer than 10 per cent of subjects spontaneously realise this. Despite claims for the power of culture and "learning," even formal training in logical reasoning does little to boost performance.

Yet people who ordinarily cannot detect violations of "if-then" rules can do so easily and accurately when that violation represents cheating in a situation of social exchange — a situation in which one is entitled to a benefit only if one has fulfilled a requirement. So suppose a mother, who has just finished baking cookies, tells her children, "If you are to eat these cookies, then you must first fix your bed." You suspect some of her children will break the rule; but how would you find out? You would check on any child with an unmade bed, to see whether she was illicitly eating cookies. You would also investigate any child who you saw eating cookies, to see whether she had fixed her bed.

This answer is immediately obvious to almost all subjects. No formal training is needed. Whenever the content of a problem asks subjects to look for cheaters on a social exchange — even when the social exchange is culturally unfamiliar and even bizarre — subjects experience the problem as simple to solve, and their performance jumps.

From a domain-general, formal view, investigating children eating cookies and children with unmade beds is logically equivalent to investigating Leos and cowards. But everywhere it has been tested, human subjects do not treat social exchange problems as equivalent to other kinds of reasoning problems. Their minds distinguish social exchange contents, and apply a domain-specific, content-dependent rule of inference that is adaptively appropriate only to that task. So far, no known theory invoking general purpose cognitive processes has been able to explain the very precise pattern of data that tests like these have generated. The data is best explained by the hypothesis that humans reliably develop circuits that are complexly specialised for reasoning about reciprocal social interactions. Parallel lines of investigation indicate that humans have also evolved additional, differently structured circuits that are specialised for reasoning about aggressive threats and protection from hazards.

In this view, a large range of problems (such as the astrological problem) are difficult because we lack circuits designed to perform content-independent logical operations ("logical reasoning"). In contrast, the social exchange problem is easy because we do have evolved circuits specialised for cheater detection. The inferences necessary for detecting cheaters are obvious to us for the same reason that the inferences necessary for echo location are obvious to a bat.

Instincts are often thought of as the polar opposite of reasoning. Nonhuman animals are widely believed to act through "instinct," while humans "gave up instincts" to become "the rational animal." But the reasoning circuits we have been investigating are complexly structured for solving a specific type of adaptive problem, they reliably develop in all normal human beings, they develop without any conscious effort and in the absence of any formal instruction, they are applied without any conscious awareness of their underlying logic, and they are distinct from more general abilities to process information or to behave intelligently. In other words, they have all the hallmarks of what one usually thinks of as an "instinct". Consequently, one can think of these specialised circuits as reasoning instincts .They make certain kinds of inferences just as easy, effortless and "natural" to us as humans, as spinning a web is to a spider or echolocation is to a bat.

The discovery and mapping of these reasoning instincts in our laboratory is, of course, merely one of the many results produced by a rapidly growing community of researchers. Taken collectively, they require a radically revised model of the human mind. Once one realises that our modern skulls house hunter-gatherer minds, whole new domains of human life become legitimate topics for research in cognitive science. The diversity of topics addressed in the recent volume, *The Adapted Mind*, gives a foretaste of this trend. In it are articles ranging from traditional topics like perception and language, to topics that are rarely treated from a cognitive perspective — the cognitive processes that govern sexual attraction, jealousy, parental love, the food aversions and timing of pregnancy sickness, the aesthetic preferences that govern our reaction to various landscapes — topics previously unaddressed or abandoned, thought to be explained by murky stew of cultural processes that could not be analysed by cognitive science.In short, locating our species in its evolutionary context is allowing us to discover the true richness of our mind's evolved design, and experience the satisfaction of deciphering why we are what we are.

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The Adapted Mind: Evolutionary psychology and the generation of culture , *J. Barkow, L. Cosmides, & J. Tooby, editors. (1992) New York: OUP.*